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the nephridia extend to the end of the branch but the intestine is absent. Setæ are apparently absent on all somites of the branch except one. Bifurcations are not uncommon among earthworms but this record is unique because of the unusual anterior position of the branch, the great inequality of the two corresponding body parts, and the absence of the intestine in the branch.

Regeneration.—Hunt ('15, Am. Nat., 49: 495-503) has found that, in *Enchytræus albidus,* posterior regeneration occurs when the animal is cut at any level between "eight segments from the posterior end of the body and eight segments from the anterior end." From the caudal end up to the middle of the body, the rate of regeneration increases almost in direct proportion to the number of segments removed. Removal of the eight most posterior somites may cause regeneration of double tails. Regeneration occurs either in fresh-water or salt-water conditions and salinity apparently has little or no influence on the rate.

Earthworms.—Smith ('15, Bull. Ill. State Lab. Nat. Hist., 10: 551-559) describes two new varieties of earthworms from Illinois and presents a tabular key to the described species of earthworms known to occur in that state. The key is accompanied by additional data on the distribution and habits of the different species. The key will be very useful in the identification of the earthworms, not only of Illinois but also of the adjacent states.

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THE OLFACTORY SENSE IN INSECTS

This problem has been a favorite one for students for one hundred and fifty years, and very diverse conclusions have been reached. N. B. McIndoo has published a summary of these conclusions under the title "The Olfactory Sense of Insects" in the Smithsonian Miscellaneous Collections, Volume 63, No. 9.

The two principal views relative to the possible seat of the olfactory organs of insects are:—first, that they are located largely upon the antennæ and palpi; and secondly, that the vesicles discovered by Hicks and situated on the legs, wings, and other parts of the body are the true olfactory sense organs.

While admitting that the removal of certain portions and experimenting with insects may aid in settling this question, the present writer is firmly convinced that observation of the normal activities of insects, and comparative study of the cytology of the various cells on the surface of the body of arthropods are more fundamental and important in determining how the function is distributed. In the opinion of the writer many arbitrary and misleading statements about the functions of surface structures of the insects are contained in the literature, largely because the authors were innocent of first-hand knowledge of the cytology of these structures. It is desired in this note to present a series of diagrammatic illustrations of the finer structure of some typical ectodermal cells taken from thousands of sections of insects.

Apparently *all* ectodermal cells are potentially sensory cells. The abundant branching of the nerve fibrils to the bases of these cells shown in Fig. 1 (Plate XVI) suggests this. The section here is of the pupa of the Tussock Moth and is perpendicular to the surface.

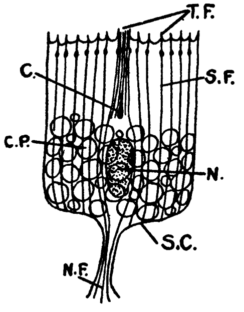

Fig. 2. Structure of typical sensory scale from Tussock Moth pupa. S.C.—sensory cell; N.—nucleus; N.F.—nerve fibril; C.P.—cyto-plastids; C.—centrosphere; S.F.—sensory fibrils; T.F.—terminals of sensory fibrils.

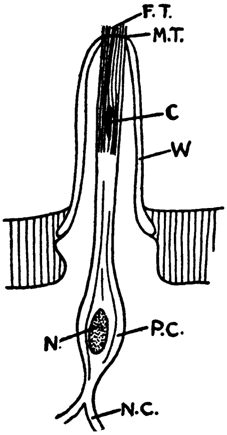

Fig. 3. Sensory Peg, *Vespa* Antenna. P.C.—peg cell; N.—nucleus; N.C.—nerve connection; W.—peg cell wall; C.—centrosphere; M.T.—membranous tip; F.T.—exposed fibril tips.

The typical internal structure of such a generalized sensory cell is shown diagrammatically in Fig. 2. In this type of cell there are two distinct types of fibrils having different origin. The fibrils marked (H) arise directly from small bodies in the outer end of the cell which in their turn arise from division of the centrosphere. These fibrils and their origin from the centrosphere suggest that they are homologous with the motile and nervous fibrils of cells.

The origin of the other set of fibrils, which always lie in and form the walls of all types of cells, is very obscure and discussion of them is reserved for another paper. These fibrils are always developed and in position before the cell wall is exposed to the air and chitinized thereby. Being of a different chemical composition these fibres are never chitinized but remain in position in the chitin matrix. Their terminals are always naked and exposed, no matter how heavy the chitin may be around them.

These fibril openings through the chitinous wall can be and are modified along with the fibril products in various functional ways. These modifications of the fibrillations of the epidermal cells form a most interesting chapter in the structure of insects. The writer holds that this structure is universal to the hypodermal cells of insects. In thousands of instances studied we have yet to find any type of such cells in which these fibrils do not perforate the chitin walls and establish connection with the outside world.

To observe these structures to best advantage the material must be well preserved and should undergo thorough staining,—preferably in Iron-alum-hæmatoxylin. The tissue should lie in the mordant two days and in the stain an equal time. This allows the stain to penetrate the fibrils through the chitin matrix which is very resistant to the stain.

The sensory cells of the epidermis may be modified from the type in various ways. They may be sunk below the surface as in Hicks' vesicles, or compounded into pore-plates beneath (or flush with) the surface, or raised into variously formed spines, scales, hairs, pegs, etc. No matter, however, what the form or elevation or degree of complexity the main structures are similar to those diagrammed in the typical cell (Fig. 2). In the later figures are given a few of the more characteristic variations from the typical epidermal cell.

Fig. 3, is a peg from the antenna of a wasp, *Vespa.* It has a membraneous tip through which the tip of a bundle of nerve fibrils are protruding. They extend quite a distance beyond the membrane and stain nicely.

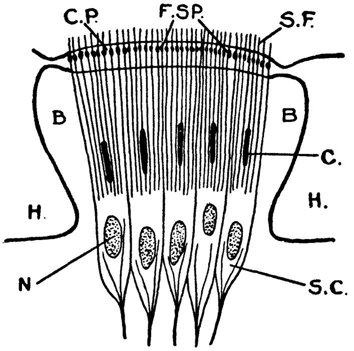

Fig. 4. Pore Plate, *Vespa* antenna. S.C.—sense cell; N.—nucleus; H.—chitin hypoderm; C.—centrosphere; B.—blood space; S.F.—sense fibrils; F.SP.—fibril spheres; C.P.—chitin pore-plate.

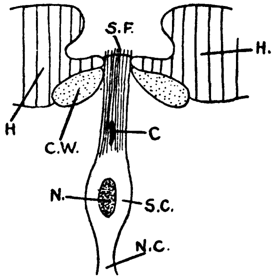

Fig. 5. Hick's Vesicle, Honey Bee. S.C.—sense cell; N.—nucleus; N.C.—nerve connection; C.—centrosphere; C.W.—chitin wall of cell; H.—hypoderm; S.F.—sense fibrils.

Fig. 4, is a diagrammatic view of a compound pore-plate from antenna of Vespa. This pore plate has a slit lengthwise of it in a surface view; many Ichneumon flies have this form with very enlongate slits. The pore plate is penetrated by the fibrils from the group of cells which compose it. The nuclear end of the cell may be extended by growth to a remote position from what it originally occupied.

The space (G) is filled with blood fluid and may by excitation and flow of blood to the antenna slightly protrude the pore plate which is suspended by a thin membranous ring. They might properly be termed erectile pore plates. At (E) on the diagram is a row of darker staining spheres which we will call for want of better name—fibril centrospheres. The ontogenetic origin of this body from the parent centrosphere and its subsequent functional history, have never been worked out, so far as we know. These pore plates, wherever found in insects and related animals, always have exposed fibrils extending through them. They are not *solid chitin disks* as assumed by many writers.

Fig. 5, is a diagram of Hicks' vesicles, which are a form of sunken peg with a membranous top through which the nerve fibrils are exposed. The chitin body (D) is the wall of the sunken peg cell.

Some writers consider this form of cell alone capable of receiving olfactory stimuli, denying that all homologous pegs which are raised varying degrees above the surface are capable of such function. The writer desires to stress the fact that these vesicles of Hicks' (1868) are but sunken pegs; and are not different in main details from those raised above the surface.

Fig. 6, is a diagram of the sense scale from the antenna of the crustacean, *Oniscus*. This shows that the nerve fibrils are exposed in a similar manner in one of the related families of the Arthropods. The writer has seen extensive areas around the mouth parts of spiders where these fibrils are exposed on flat membranes.

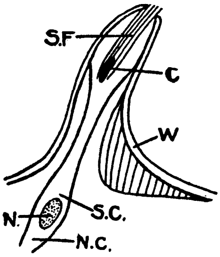

Fig. 6. Sense Scale, *Oniscus* antenna. S.C.—sense cell; N.—nucleus; N.C.—nerve connection; W.—wall of scale; C.—centrosphere; S.F.—sense fibrils at tip.

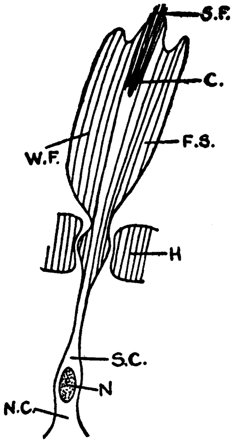

Fig. 7. Sense Scale, *Pyrameis* antenna. S.C.—sense cell; N.—nucleus; N.C.—nerve connections; H.—hypoderm; W.F.—wall fibrils; F.S.—flat part of scale; C.—centro sphere; S.F.—sense fibrils.

Fig. 7, is a diagram of a scale from the antenna of a butterfly—*Pyrameis*.

From observation of many thousands of these various scale types the writer is convinced that the evidence shows many forms of epidermal scales which have all the cytological details necessary to receive in some degree olfactory stimuli.

As to what extent any particular type or set of cells actually do receive such stimuli we deem it impossible at present to state. Experiments which show that insects can smell both with and without the antennæ are of little value.

Some authors contend that the Hicks' vesicles on the legs are olfactory in function, while they absolutely deny that apparently homologous cells on the antennæ and palpi are capable of receiving such stimuli. The antennæ and palpi are but leg rudiments, a pair from each of the five segments of which the head is composed, being modified for various uses. In some forms of insects such as some Chironomidæ the antennæ are becoming rudimentary, while the first pair of true legs are greatly enlongated and used as sense organs, being extended toward and waved toward objective points. In other insects which do not feed in the adult state, such as some Ephermeridæ, the antennæ are very rudimentary.

Again some insects which do not feed in adult stages, such as some families of moths, have very large and much branched antennæ. In this case they seem to be connected with sexual functions. An almost endless list could thus be given of the modifications of the various forms of legs in the different insect families. These legs are homologous. There is nothing to indicate that their epidermal cells may not be homologous also. The minute structure of these cells as detailed above further reinforces the conviction of their homology. But the fact remains that all insects respond to odors, no matter what the modificactions of the epidermal appendages.

Many experiments have been devised by various students to try and show by mutilation which organs are olfactory and which not. Antennæ, palpi, tongues, legs, wings, styles, halters, stings, etc., have been removed in an endeavor to locate the olfactory sense. While the results are equivocal, most observers agree that the sense is not confined to any one set of appendages. We believe that the antennæ can and do act as receptors of olfactory stimuli under normal conditions, both for the reasons given above and because of observations upon the animals. Extensive observations were made this summer on normal insects engaged in feeding and other duties, to try and determine this point. For many days the various bees which visited a patch of columbine were observed. As the nectary tubes of these flowers are too long for the tongue of the bees, they invariably went to the rear of the flower and ripped the nectary open with the tongue. The bee working on the outside of the flower was in good position to show the normal use of the antennæ. The antennæ were invariably waved toward, then placed in direct contact with the nectary, and the presence or absence of food determined thereby. Out of thousands of bees which visited the flowers not one was observed to feed without first making an examination with the antennæ.

Many ants were studied in their travels, and the antennæ were found to be constantly in use. When near enough, making contact with the object; when further away, waving them towards the object.

Many species of Ichneumon flies were observed. Their antennæ are almost constantly in motion, apparently receiving most of their stimuli without contact.

For these reasons we believe that there are many types of epidermal cells widely scattered over the body which are normally capable of and do receive olfactory stimuli.

The arbitrary assumption of this function as belonging to any one type of cells without adequate cytological investigation can but lead to scientific mistakes. The call is for more and better cytological work.

Battle Creek, Mich. E. W. Roberts.

ARACHNOIDISCUS IN MARYLAND DIATOMACEOUS EARTH

About a year ago a friend in Maryland sent me a piece of diatomaceous earth which was uncovered by the excavation for a State road. It did not look very promising, being very sandy. Some time later, however, I cleaned a part of it and during the process was rather disgusted to find fragments of *Arachnoidiscus* mixed with it. It never seemed possible that the diatom might belong there, so I cast the stuff away and started anew only to find them in the new batch. I then became suspicious, but remembering an article I had read by Kitton in an old number of Science